

BIOTECHNOLOGY & ITS APPLICATIONS

* Biotechnology deals with Industrial scale production of
 → biopharmaceuticals
 → biologicals

Novel capabilities ← to bring in these org.
 their metabolic machinery
 microbes
 fungi
 plants
 animals
 using genetically modified org.

* Application of Biotechnology include
 → Therapeutics
 → diagnostics
 → Genetically modif. crops for agriculture
 → Processed food
 → Bioremediation
 → waste treatment
 → energy prod.

* 3 critical Research areas of Biotechnology are :

(i) Providing the best catalyst in form of improved organism
 usually
 (ii) Creating optimal conditions
 through engineering for catalyst to act
 (iii) Downstream processing technologies to purify
 protein
 organic comp.

Biotchnological Applications in Agriculture

* 3 options that can be thought for ↑↑ food production

Agro-chemical based agriculture
 Organic agriculture
 Genetically engineered crop based agriculture.

GREEN REVOLUTION → Succeeded in 3X Food supply
 Not enough to feed growing human population.
 but yet

• Increased yields partly due to Use of improved crop varieties
 mainly due to
 Use of better management practices
 Use of agrochemicals
 Pesticides
 Insecticides

• However → For farmers in developing world.
 Agrochemicals too expensive.

Further ↑ in yield not possible with existing varieties using conventional Breeding

Use of Genetically modified $\xrightarrow{\text{solution to}}$ Abiotic problems

GMO (Genetically Modified Organism)

organism
whose genes
are altered
by manipulation

- Plants
- Bacteria
- Fungi
- Animals

★ Genetic Modifications has:

i) made crops more tolerant to Abiotic Stress

- Cold
- drought
- Salt
- heat

ii) reduced reliance on Chemical pesticides → Pest Resistant crops.

iii) helps reduce Post harvest Losses.

iv) increase efficiency of mineral usage by plants

prevents early exhaustion of fertility of soil

v) enhanced nutritional value of food

eg → Golden rice.

(Vitamin A enriched)

• GM has been used to create tailor made plants to supply Alternative resources to industries.

Starches

Fuels

In terms of
Pharmaceuticals

* (Bt Toxin) produced by Bacterium: Bacillus Thuringiensis

has been
cloned from

Bacteria

been
expressed in

Plants

to provide

Resistance to
insects without
need of insecti-
cides.

Biopesticide

in effect
creates a

Examples of Plants

Bt cotton Bt corn Bt rice Bt tomato Bt potato Bt soybean

Bt Cotton

Some strains of Bacillus thuringiensis

produce

Proteins

that kill certain insects such as

Lepidoptera

Coleoptera

Diptera

• tobacco budworm

• beetles

• Flies

• Army worm

• Mosquito

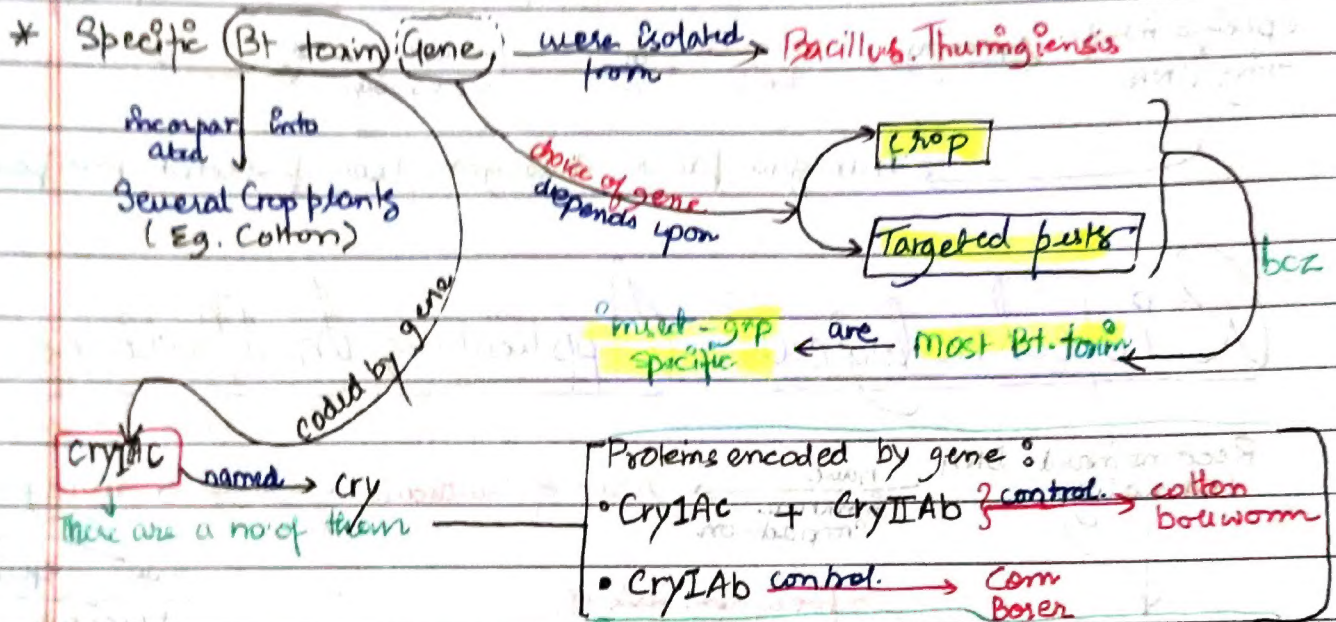
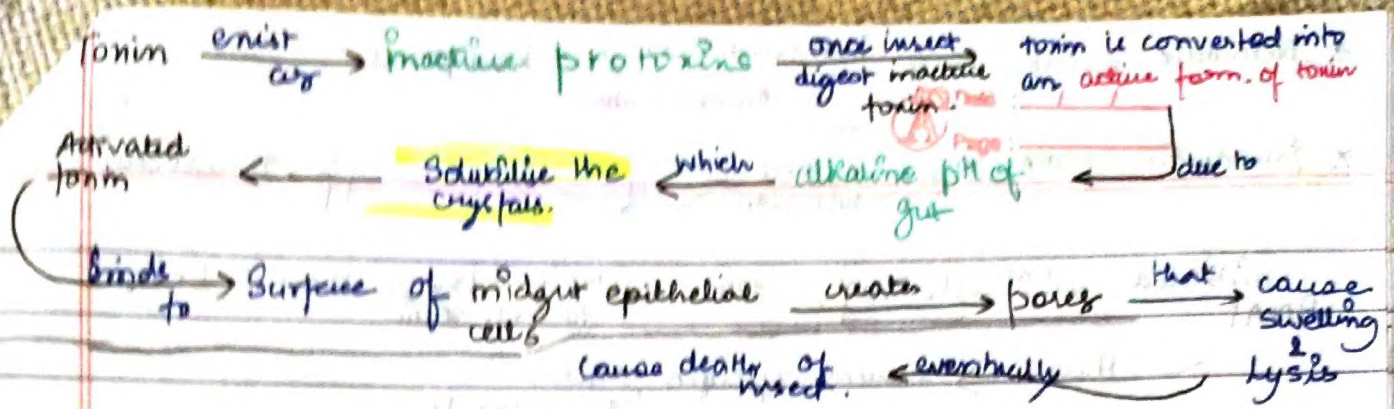
B. Thuringiensis forms Protein Crystals

during

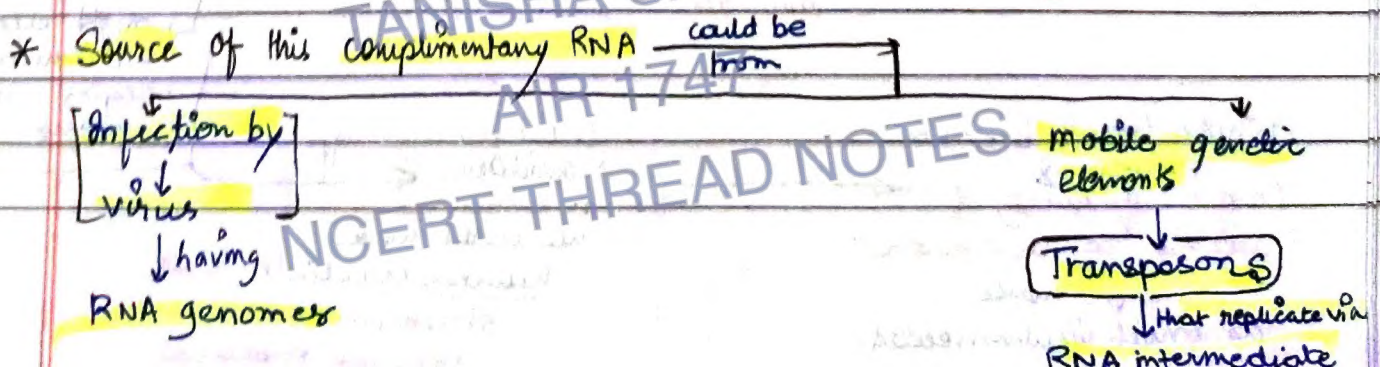
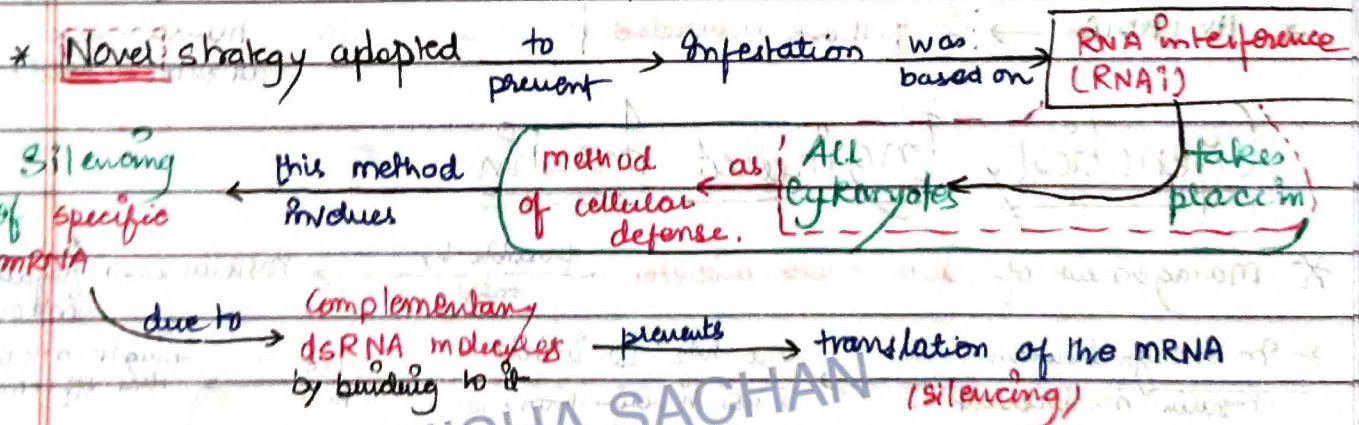
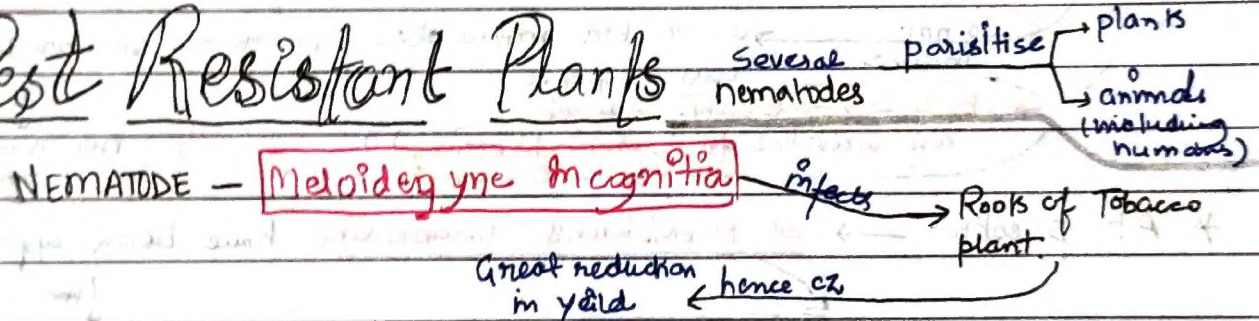
particular phase
of their growth

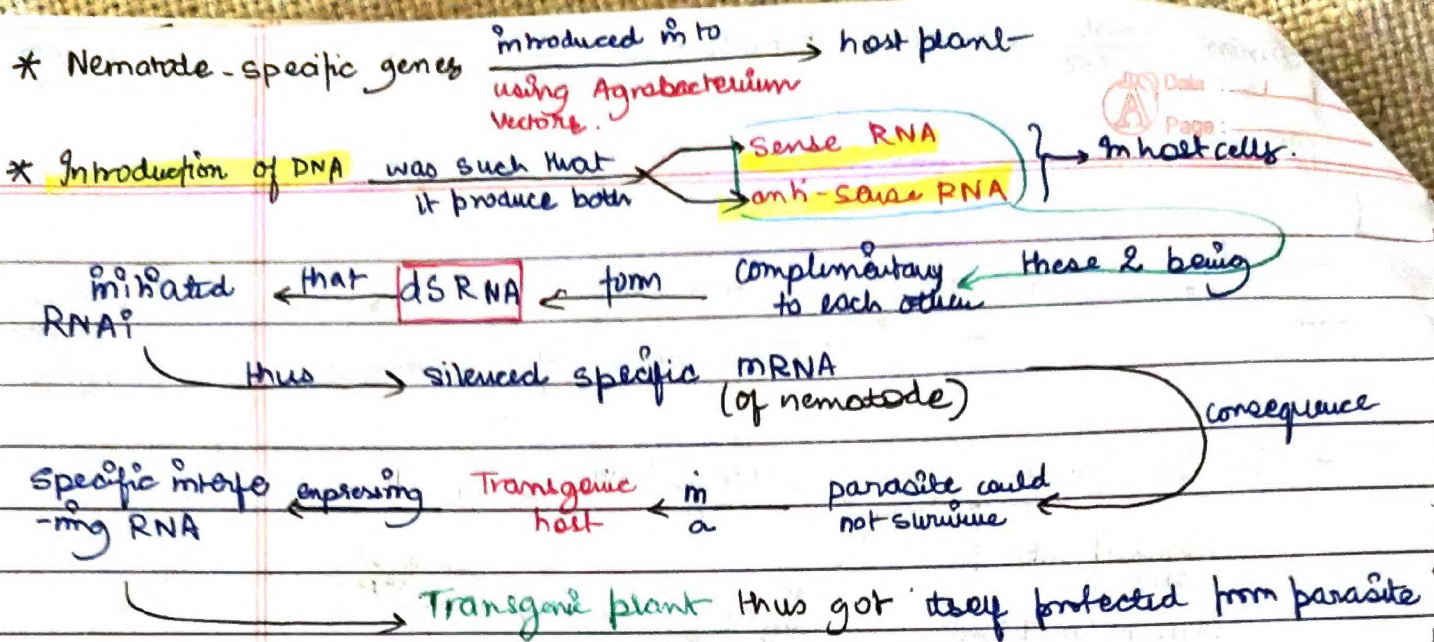
contain

Toxic insecticidal proteins

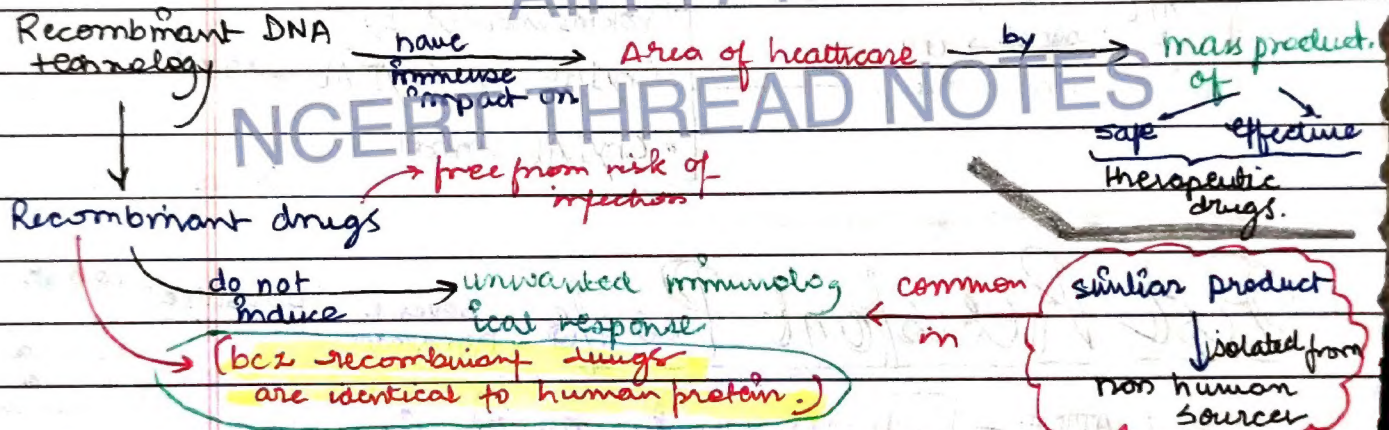


Pest Resistant Plants





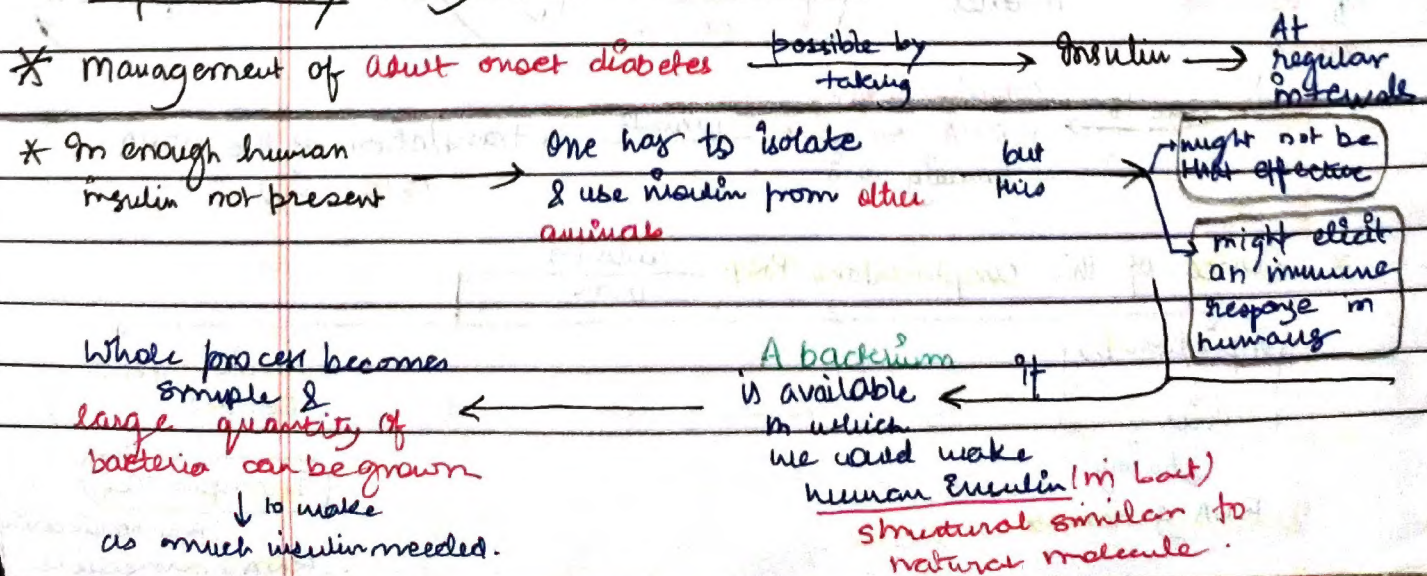
Biochemical Applications In Medicine

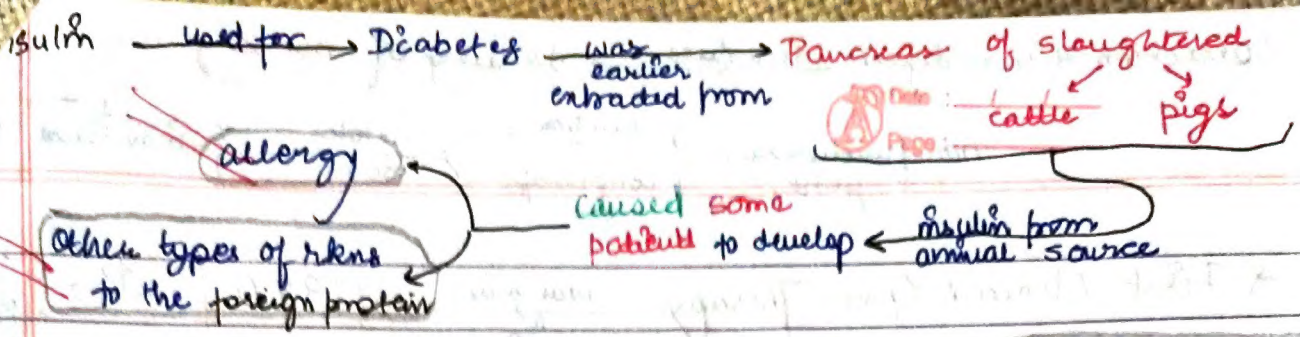


* At present → 30 recombinant Therapeutics have been approved for human use (all over world)

* IN INDIA → 12 of these marketed

Genetically Engineered Insulin



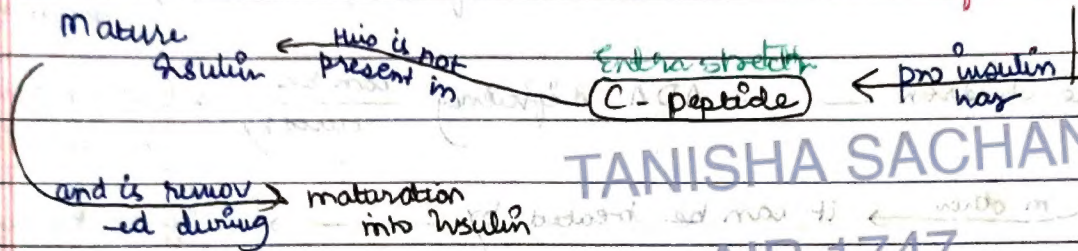


* INSULIN consists \rightarrow 2, short, polypeptide chains

chain A \updownarrow linked by disulphide bridges \updownarrow chain B

In mammals $\xrightarrow{\text{insulin is synthesised as}}$ PRO-HORMONE

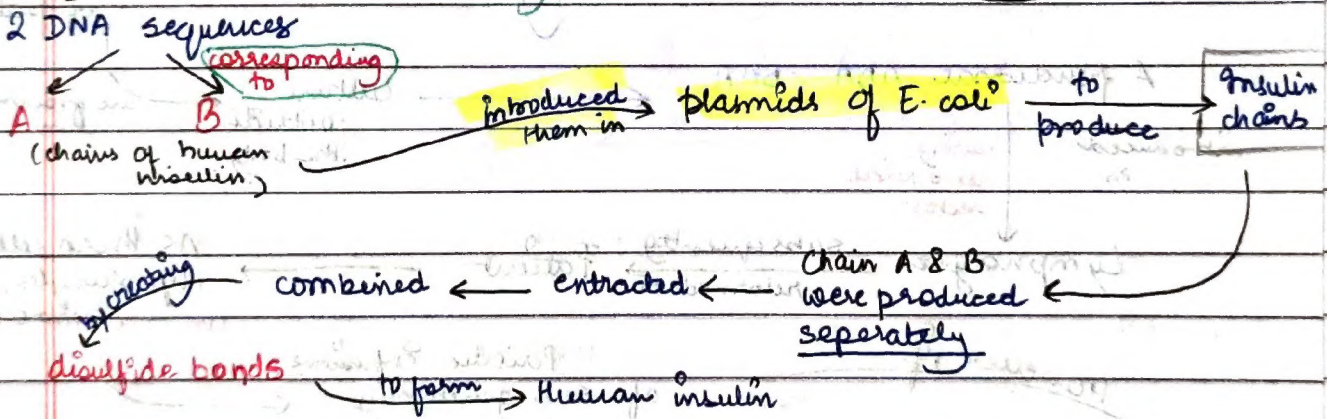
{ like pro-enzyme, pro hormone needs to be processed before it becomes fully mature functional hormone }



* Main challenge for production of insulin $\xrightarrow{\text{using}}$ rDNA technique

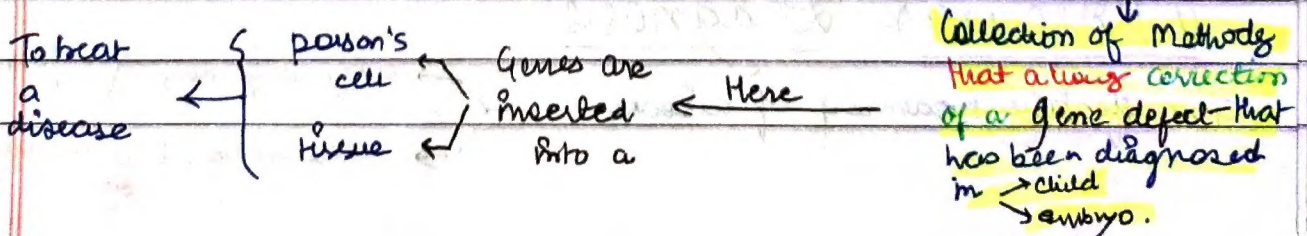
was \rightarrow Getting insulin assembled into mature form.

in 1983 \leftarrow Eli Lilly (An American company)



Gene Therapy

Person born with hereditary disease \rightarrow Corrective therapy can be taken \rightarrow known as **GENE THERAPY**



Correction of Gene defect involves → delivery of normal gene into individual embryo

non-functional gene. → function of compensates for → to take over

* First Clinical Gene Therapy was given in 1990 to 4 year old girl

This enzyme crucial for immune system to function

Adenosine deaminase (ADA) deficiency

with

This disorder is caused due to deletion of the gene for adenosine deaminase

* In some children ADA deficiency can be cured by Bone marrow Transplantation

in other it can be treated by Enzyme Replacement therapy

Not completely curable (not curable)

Injection to patients is given by Functional ADA

On this

* As first step towards Gene therapy Lymphocytes from blood of patient

A functional ADA cDNA

introduced in

using retroviral vector.

culture outside the body

are grown in

Lymphocytes subsequently returned to Patient

As these cells (lymphocytes) are not immortal.

However if

Periodic infusions of such genetically engineered cells lymphocytes needed.

Gene isolate from marrow cells prod. ADA

introduced into Cells at early embryonic stage. → It could be permanent cure.

Molecular Diagnosis

For effective treatment of disease

early diagnosis

understanding its pathophysiology

Conventional Methods of diagnosis eg { Serum analysis
urine analysis }

early detection not possible

- Techniques that serve purpose of early diagnosis { Recombinant DNA technology
PCR (Polymerase chain rxn)
ELISA (enzyme linked immunosorbent assay) }

* Presence of pathogen { bacteria
virus } is normally suspected when Pathogen has produced a disease symptom.
↓
By this time conc. of pathogen ↑↑ high in body.

* When very low ↓↓ conc. of pathogen present (at time when symptoms of disease not available) can be detected by Amplification of their nucleic acid by PCR.

* PCR routinely used to detect HIV in suspected AIDS patient.
used to detect mutations in genes in suspected cancer patients
powerful technique to identify many other genetic disorders.

* Single stranded DNA/RNA { tagged with a Radioactive molecule (PROBE) is altered to hybridise to its complementary DNA
↓ followed by Clone of cells in Complementary DNA
detection using Autoradiography.

but Photographic film. will not appear on Clone having mutated gene.
probe will not have complementarity with mutated gene.

* ELISA is based on Principle of: Antigen - Antibody interaction

proteins
glycoproteins
presence of antigen OR
detecting the antibodies
↓ synthesised
against pathogen

Infection of pathogen can be detected by

TRANSGENIC ANIMALS

* Animals that have had their DNA manipulated to possess or express an extra foreign gene

TRANSGENIC ANIMALS

Rats Rabbits Pigs Sheep Cows Fish

> 75% of existing transgenic animals are mice

(i) Normal Physiology & Development?

Transgenic animals can be specifically designed to allow the study of how genes are regulated and how they affect normal functions of body & its development

Study of complex factors involved in growth
[eg. insulin-like growth factor]

* By introducing genes from other species that alter the formation of this factor.

is obtained about the information biological effects that result and studying Biological role of the factor in the body.

TANISHA SACHAN

AIR 1747

(ii) Study of disease

NCERT THREAD NOTES

Many transgenic animals are designed to ↑ our understanding of how genes

Species made to serve as models, contribute to development of disease

for human disease so that investigation of new treatments for disease is made

Cancer
Cystic fibrosis
Rheumatoid Arthritis
Alzheimer's
such as Today transgenic models exist for human disease

(iii) Biological Products

* Medicines required to treat certain human diseases can contain Biological production
such biolog. prod. expensive to make

Transgenic animals $\xrightarrow{\text{that produce}}$ useful biological products $\xrightarrow{\text{can be created by}}$ introduction of the portion of DNA / genes which codes for particular products

Examples:

1) Human protein - α -1-antitrypsin $\xrightarrow{\text{used to treat}}$ Emphysema.
 \rightarrow similar attempts are being made for Treatment of \rightarrow Phenylketonuria, Cystic fibrosis

* In 1997, First transgenic Cow - ROSIE $\xrightarrow{\text{produced}}$ human protein enriched milk. (2.4 gm/Litre)
Human Alpha-lactalbumin $\xleftarrow{\text{milk contained}}$ $\xrightarrow{\text{was nutritionally}}$ more balanced product \rightarrow for babies (than cow natural milk)

iv) Vaccine Safety:

* Transgenic mice are being developed for testing the safety of vaccines before they are used on humans.

Transgenic mice $\xrightarrow{\text{are being used to}}$ test the safety of polio vaccine
 \rightarrow If successful \rightarrow monkeys will be replaced by mice to test the safety of batches of vaccine

v) Chemical Safety Testing:

\rightarrow known as Toxicity / Safety testing
Procedure is same as \rightarrow that used for testing toxicity of drugs.

Transgenic animals \rightarrow are made to that carry genes which make them more sensitive to toxic subst. than non-transgenic animals.

* Toxicity testing in such animal

Effects are then studied

Exposed to the toxic substance

\leftarrow they are then

will allow \rightarrow to obtain results in less time.

ETHICAL ISSUES

* Manipulation of living organism by human race \rightarrow cannot go further, without regulation

* Some ethical standards are req. \rightarrow to evaluate morality of humans activities that might harm living organisms.

Beyond morality of such issues

Biological significance of such things important.

Genetic modification of organism

When such org. are introduced in ecosystem.

unpredictable results

can have

therefore

Indian Government.

has set up

GEAC (Genetic Engineering Approval Committee)

① Validity of GM research

Decisions regarding

which will make

② Safety of introducing GM-org for public services

* The modification of usage

of living organisms

for Public Services

food source

medicine source

problems with patent granted for same

* Growing public anger.

Certain companies

are being granted

Patents

for

products technologies

famous indigenous people of specific region/country

by

long been identified developed used

that have

Genetic material plants

that make use of

RICE - Imp food grain

- Presence goes back 1000+ years in Asia's agricultural history.

- Estimated - 200,000 varieties of rice in India alone.

- Diversity of rice - In India - one of the richest in world.

- BASMATI RICE - distinct for unique aroma flavor

→ 97 documented variety of Basmati

grown in India

- Reference to Basmati in

ancient texts folklore poetry

as it has been grown for centuries.

- In 1997, An american company

got

Basmati rice through

US patent & Trademark office

this allowed company to

sell 'new' variety of Basmati in

US

abroad.

this new variety is derived from.

Indian farmer's variety

Indian Basmati

X Semi dwarf varieties

claimed as

Invention/novelty

patent extends to → functional equivalents → implying that other people could be restricted by patent → Selling Basmati Rice

* Several attempts have been made to Patent → Uses products → processes } based on Indian Traditional Herbal Medicines [e.g. Turmeric, Neem]

* Hence → If we are not vigilant → Do not immediately counter these patent application } Other countries may encash on → Rich legacy

⇒ BIOPIRACY — Use of bioresources by multinational companies & other organisations → without proper Authorisation → without compensation → without people concerned

* Most of Industrialised Nations → rich financially → poor in biodiversity & traditional knowledge

* Developing & Underdeveloped world → rich in → Biodiversity & Traditional Knowledge → related to Bio Resources

Modern application ← can be exploited to develop Bio resources → related to → can also be used to save effort, time, expenditure → during Commercialisation

* Growing → unjust, inadequate compensation, Benefits } sharing b/w developed & developing countries

Such unauthorised exploitation of their bioresources & Traditional Knowledge → Therefore some nations are developing laws to prevent

* Indian Parliament

recently cleared

Second Amendment of Indian Patents Bill

Date: _____
Page: _____

patent terms emergency provision

Research

Development inhibitive

including

such issues into consideration

that sake

GOLDEN RICE

Vit A

β -carotene

precursor for provitamin A

Blood

doesn't have

protease

nuclease

Orally active pharmaceutical protein

used for treatment of

hepatitis B

influenza

Herpes

only problem is they can get digested/denatured by stomach acidic environment, hence they are encased in tablets which solubilise in intestine & they are directly absorbed.